

## ***ANNEALING THERMOLUMINESCENT DOSIMETER CHIPS***

**Purpose** This Air Quality Group procedure describes the steps to anneal the individual TLD chips in dosimeters prior to their deployment to the field.

**Scope** This procedure applies to annealing of the 1/8" TLDs used for photon measurements in the environmental surveillance network as part of the Direct Penetrating Radiation Monitoring Network (DPRNET) of ESH-17.

**In this procedure** This procedure addresses the following major topics:

<b>Topic</b>	<b>See Page</b>
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**Hazard Control Plan** The hazard evaluation associated with this work is documented in Attachment 1: Initial risk = **low**. Residual risk = **low**. Work permits required: **none**. First authorization review date is one year from group leader signature below; subsequent authorizations are on file in group office.

**Signatures**

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01/25/01

### **CONTROLLED DOCUMENT**

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## General information about this procedure

**Attachments** This procedure has the following attachments:

Number	Attachment Title	No. of pages
1	Hazard Control Plan	2

**History of revision** This table lists the revision history and effective dates of this procedure.

Revision	Date	Description of Changes
0	10/17/97	New document.
1	10/29/99	Changed anneal process to use oven rather than TLD reader.

**Who requires training to this procedure?** The following personnel require training before implementing this procedure:

- Lead technician responsible for TLDs

**Training method** The training method for this procedure is **on-the-job** training by a previously-trained individual and is documented in accordance with the procedure for training (ESH-17-024).

**Prerequisites** There are no prerequisites for this procedure.

## General information, continued

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### Definitions specific to this procedure

Quartz glass rack and slips: hand-blown quartz glass made at the LANL glass blowing facility specifically for this purpose.

Thermocouple: a device used to measure the temperature difference. In this application, there are 2 separate units for measuring 2 different temperatures, each connected to a common display with selectable channels.

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### References

The following documents are referenced in this procedure:

- ESH-17-024, “Personnel Training”
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### Note

Actions specified within this procedure, unless preceded with “should” or “may,” are to be considered mandatory guidance (i.e., “shall”).

## Loading and annealing TLD-100 chips

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<b>Description of operation</b>	This process involves removing the five individual chip elements from each dosimeter and placing them into quartz glass slips. The slips are then loaded into a quartz glass rack and then into the first oven for annealing for one hour. At the end of the allotted time, the slips are placed onto copper slabs for thermal quenching, reloaded into the rack, and placed in the next oven for three hours. At the end of this process, the TLD chips have been annealed to remove any residual TL signal and to stabilize them for any potential sensitivity changes. They are then reloaded into their holders and are ready for field deployment.
<b>Calibration of thermocouples</b>	The thermocouples need annual calibration. Ensure the calibrations are up to date. Send the thermocouples to a suitable calibration lab (e.g., Standards and Calibration Group) and ensure they will be returned in time for use. Send the calibration records to the appropriate records series for storage.
<b>Record work performed in logbook</b>	In the TLD field and lab logbook, record the date and time all work was performed (reference may be made to this or other procedure that was followed) and describe the amount of work completed or remaining. Also document any problems or anomalies encountered such as temperature fluctuations, etc.
<b>Segregate “high exposure” chips</b>	Dosimeters placed at some locations routinely receive exposures of >150 mrem per quarter. These chips, over time, will respond differently from the other chips. Keep the chips used at any location that routinely receives >150 mrem/quarter segregated from all the other chips and ensure the dosimeters with these chips are appropriately marked so they can be placed at these locations.
<b>Use care with glass racks slips</b>	Use extreme care in the use and handling of the glass racks and slips: they are very difficult and expensive to replicate. They are designed to accommodate only the 0.035” thick TL chips. No other size of material will fit inside them.

## Loading and annealing TLD-100 chips, continued

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### Equipment needed

Collect the following equipment in Building 1001 at TA-54.

- quartz glass slips to hold all of storage field set of 1/8" chips (usually 8)
  - one quartz glass rack to hold the glass slips above
  - one glass petri dish or ceramic bowl to hold all chips
  - one pair of small Teflon-tipped tweezers to remove plastic inserts
  - a "pill dispenser" type tool for loading the chips into the slips
  - a pair of tongs
  - one long spatula
  - one pair "Zetex" insulated gloves used for high temperatures (asbestos free)
  - lab coat or other long-sleeved apparel for covering arms when removing racks from ovens
  - 2 small ovens located in Bldg 1005, Room 1; one set at 400°C and second set at 80°C
  - Omega digital thermocouple display panel (on benchtop with 2 thermocouples leading to the two ovens)
  - Logbook for recording all times, temperatures, and any anomalies encountered during the anneal process.
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### Warm up small oven

Turn on the power to the small oven (Fisher IsoTemp) the night before you anticipate performing an anneal. This will allow the oven to stabilize at 80°C by the next day. Ensure the thermocouple display on the Omega display (channel 2) indicates 80°C.

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### Steps to anneal chips

Perform the following steps to load the chips into the ovens and anneal them:

Step	Action
1	Gather from storage all of the dosimeters required for a field change-out. Also include enough dosimeters for the QC's (one per disk of 10 dosimeters) and the 25 dosimeters to be used for the fade correction factors.
2	Open a dosimeter and dump the 5 chips into the glass petri dish. If the chips do not fall out, remove the plastic insert using the Teflon-tipped tweezers. Use the Teflon-tipped tweezers to pick up any chips as necessary.

*Steps continued on next page.*

## Loading and annealing TLD-100 chips, continued

Step	Action
3	When all of the chips have been dumped from all of the dosimeters, use the provided tool to load chips into a quartz glass slip. Load the slip until it is near the top (about 150 chips).
4	Continue this process until all of the chips have been loaded into the glass slips. Place the “high exposure” chips in a separate slip and keep track of this slip. Place the slips into the quartz glass rack beginning in the middle of the rack and working outwards. Try to place equal numbers of slips on each rack layer to ensure proper heating while in the ovens.
5	Take the rack to the large Thermolyne oven. Place the rack, centered, inside the oven cavity and turn the oven power on.
6	Set the digital display to 400°C by pressing the up arrow on the small display keypad.
7	Power on the digital “Omega” thermometer (with the two thermocouples leading to both annealing ovens) and select the “A” channel (for the first anneal cycle).
8	Watch the digital thermometer located on the benchtop near the oven(s) and when the scale reads 400°C, watch it for a few minutes to ensure that the temperature does not exceed this setting. If the temperature begins to exceed this setting, decrease the oven’s temperature setting (by pressing on the down arrow) until the temperature on the digital thermocouple indicates 400°C. Conversely, if the temperature is set too low, raise the setting on the oven until the proper 400°C is reached. Watch this setting for a couple of minutes to ensure the proper temperature is reached. When satisfied that the temperature is set correctly, begin timing the anneal for one hour.
9	After one hour, open the door wearing the insulated gloves and long sleeves. Use the tongs and long spatula to remove the quartz glass rack from the oven. Place it on the copper slabs. <b>WARNING: Use caution in removing the rack. The inside temperature of 400°C will feel extremely hot but the gloves will protect you.</b>
10	Using the tongs and spatula, carefully remove each glass slip from the rack and place it on the copper slabs for quenching (quick cooling). Place the slips so that there is a small space between each one to enhance cooling. Keep track of the slip that contains the “high exposure” chips.

*Steps continued on next page.*

## Loading and annealing TLD-100 chips, continued

Step	Action
11	Switch the digital “Omega” thermometer (with the two thermocouples leading to both annealing ovens) to the “B” channel. Ensure the small oven (Fisher IsoTemp), which was turned on the day before, has stabilized at 80°C.
12	When the rack has been loaded with the cooled slips, place it in the center of the small oven. Record the time and temperature of the start of the anneal process in the logbook.
13	Carefully watch the temperature display during the three-hour anneal cycle as only very small variations (<5°C) from the 80°C will cause significant sensitivity changes in the TLD chips. Continue to watch the temperature for the entire three hours. Record any changes in temperature >5°C or any other anomalies in the logbook.
14	At the end of the cycle, remove the rack from the oven (use the gloves as the glass rack and slips are at 80°C) and quench the chips as described in step 10.
15	When slips have cooled to ambient temperature, dump all of the chips into the glass petri dish. Keep the “high exposure” chips segregated.

## Reloading dosimeters after anneal cycle

**Description of process** After the chips have been annealed, it is necessary to reload the chips into their respective holders and to keep them at cool temperatures ( $<20^{\circ}\text{C}$ ) until field deployment.

**Steps to reload dosimeters** Perform the following steps to reload the dosimeters.

Step	Action
1	From the petri dish, use the Teflon-coated tweezers and carefully pick up each chip and place it into the plastic bottom of the holder (acorn). Align them so that they are on the bottom, flat, and on top of each other. Place the plastic anchor insert back into the acorn and secure the top. Load the “high exposure” chips separately into their dosimeters.
2	Continue this operation following step 1 above until all of the annealed dosimeters have been reloaded.
3	If there is a break in the loading process ( $>10$ minutes), store <b>all</b> the dosimeters (including those not loaded yet) in a cooler until the process can be resumed. <b>DO NOT LEAVE DOSIMETERS ON THE COUNTER WHERE SUNLIGHT COULD REACH THEM.</b>
4	Store the annealed dosimeters inside the storage vault in Building 1001 (Cave) until time for field deployment.

**Record work performed in logbook** In the TLD field and lab logbook, record the date and time all work was performed (reference may be made to this or other procedure that was followed) and describe the amount of work completed or remaining. Also document any problems or anomalies encountered such as temperature fluctuations, etc.



## Records resulting from this procedure

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### Records

The following records are generated as a result of this procedure:

- entries in log book and files from electronic database (book will be submitted pursuant to ESH-17-011)
- calibration records for the thermocouples (when due annually or more often)



### HAZARD CONTROL PLAN

1. The work to be performed is described in this procedure. Procedure title:  
**“Annealing Thermoluminescent Dosimeter Chips”**

2. Describe potential hazards associated with the work (use continuation page if needed).

Potential burns from picking up chips too soon after anneal process.  
Ovens used to anneal chips.

3. For each hazard, list the likelihood and severity, and the resulting initial risk level (before any work controls are applied, as determined according to LIR300-00-01.0, section 7.2)

Potential burns from picking up chips too soon after anneal process -- Negligible / Improbable = Minimal.

Burns from use of ovens and quartz glass rack and slips, which are at 400 and 80 degrees -- Moderate / Occasional = Low

Overall *initial* risk: ☐ Minimal ☒ Low ☐ Medium ☐ High

4. Applicable Laboratory, facility, or activity operational requirements directly related to the work:

☒ None ☐ List: Work Permits required? ☒ No ☐ List:

### HAZARD CONTROL PLAN, continued

5. Describe how the hazards listed above will be mitigated (e.g., safety equipment, administrative controls, etc.):

Burns- since the burns received have been minor, no mitigation has been required (since the first occurrence, it hasn't been repeated).

Burns from ovens -- heat resistant gloves with long cuffs will be used with forceps or tongs to handle the hot racks holding the chips.

6. Knowledge, skills, abilities, and training necessary to safely perform this work (check one or both):



Group-level orientation (per ESH-17-032) and training to this procedure.



Other → See training prerequisites on procedure page 2. Any additional describe here:

7. Any wastes and/or residual materials? (check one) ☒ None ☐ List:

8. Considering the administrative and engineering controls to be used, the *residual* risk level (as determined according to LIR300-00-01.0, section 7.3.3) is (check one):



Minimal



Low



Medium (requires approval by Division Director)

9. Emergency actions to take in event of control failures or abnormal operation (check one):



None



List:

For burns and any other injuries from handling of chips and hot glass, provide first aid and then see that injured person is taken to ESH-2 or hospital.

Signature of preparer of this HCP: This HCP was prepared by a knowledgeable individual and reviewed in accordance with requirements in LIR 300-00-01 and LIR 300-00-02.

Preparer(s) signature(s)

Name(s) (print)

/Position

Date

Signature by group leader on procedure title page signifies authorization to perform work for personnel properly trained to this procedure. This authorization will be renewed annually and documented in ESH-17 records. Controlled copies are considered authorized. Work will be performed to controlled copies only. This plan and procedure will be revised according to ESH-17-022 and distributed according to ESH-17-030.

